September 26, 2016

Federal Communications Commission
445 12th Street, SW
Washington, DC 20554

RE: Proposal of iPosi, Inc. for Certification as an ESC operator
Request for Supplemental Information
(GN Docket 15-319)

iPosi respectfully submits its response to the FCC's September 2 Request for Supplemental Information.

Per Section 0.459 of the Commission's rules, iPosi requests confidential treatment of this response.

Sincerely,

/S/
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Introduction

This document is in response to the September 2, 2016 Request for Supplemental Information from the FCC asking iPosi for more information in Questions 1 through 4, related to Title 47 of the U.S. Code of Federal Regulation FCC Rules and Regulations (§ 96.67(c)(2)). With regards to the overarching requirement of Naval radar signal detection: iPosi will not be able to meet this requirement in the first wave.

In order to explicitly answer questions 1- 4 of the RFI:

1) iPosi protects incumbents by *measuring* the RF losses in the direction of GNSS satellite passes (at 1.575GHz and 1.176GHz). A SAS can then use this knowledge to refine propagation losses in the direction of incumbents, and thus, respect necessary C/I ratios.
2) The assertions based on the sequence diagram are correct. The iPosi CBSD-based ESC would rely on the traditional coastal Naval ESC during the period it takes to generate an RF loss table (as seen by CBSD). If the RF containment in coastal directions is sufficient, the SAS can calculate a grant power for the CBSD, which ensures a proper C/I ratio, even assuming the closest proximity of Naval radar.
3) Correct. iPosi is not designed to sense radar signals' presence or direction of origin. If the local SAS issues a grant suspension because of Naval presence, the CBSD must operate below the maximal power granted by the SAS using the previously generated (in *situ*) loss table.
4) Correct. The iPosi solution is designed for Category A (indoor) CBSDs. As to whether iPosi could be used for outdoor CBSDs, or whether iPosi enabled sensors will be installed along the coastline, please read below.

Despite the non-compliance with certain ESC requirements, iPosi believes it serves as a "Distributed ESC" in that it augments or supplements the ESC radar detection mechanism with building RF loss-measurements in the direction of navigable waters. When a CBSD is equipped with iPosi technology and works to supplement an ESC, we call it "CBSD/D-ESC" to represent the distributed ESC concept. iPosi cannot presently provide a radar detection system by itself, but it can provide RF loss-measurement service to SAS's, to provide additional useful information for protection from, and to, Naval radar. In either of the methods described here, the requirement of section 96.67(c)(2)) can be met, in principle, for a second wave ESC, or perhaps waved by invoking 96.67(b).

iPosi will consider providing fully compliant radar Detection ESC in a later wave. That said, please read below regarding iPosi's participation in the ***Winnforum*** committees.

iPosi Technology - further information

iPosi has further developed the building containment loss concept since the ESC proposal filing. The fundamental ESC approach requires that all CBSD's in the ESC coverage region are required to cease operation when a Naval radar is detected. This of course reduces the capacity to zero during the Naval Radar event. iPosi provides scaling factors to the RF power of the CBSD's according to the measured containment loss in the direction of the Naval Radar when the radar signal is detected. This will provide a soft capacity reduction and, in some cases, perhaps no reduction at all. iPosi believes this increases shared spectrum resources, consistent with the FCC's intention.

This concept extends to the protection of Maritime radar, FSS, and fixed or airborne radar. It fits into the SAS/ESC architecture with little change to protocols and no change to hardware. It takes advantage of the existing GPS satellite infrastructure, is enhanced by drawing on other international GNSS systems, and does not require a massive special HW architecture for support.

The idea is extendable to other frequency bands and only requires a scaling factor for L1 and L5 to the band of interest. This allows the 3.5 GHz band to open up all of the shared spectrum.

iPosi has joined the ***Winnforum*** and is actively engaged in the Spectrum Sharing Committee to incorporate this concept into a future version of the CBRS specification. As a result, it will be possible to combine the iPosi containment loss method with the propagation path loss model adopted by the Winnforum.

iPosi has analyzed the benefit of the loss-measurement method to CBSD systems using the NTIA protection methodology of the NTIA in TR-15-517r1. In our urban example we compare the stochastic method of the NTIA to the more deterministic method of iPosi. The result is 16.6 dB less interference for the same parameters using the iPosi method. This 16.6 dB margin reduces the Naval radar protection distance, or increases the capacity of the 3.5 GHz system. Using free-space path-loss (20dB/decade), 95% tile protection distance of 10 Km is reduced to 1.5 Km with knowledge of the 16.6 dB margin.

The Appendix provides brief description of an example using the iPosi/TR 15-517 method compared to the iPosi loss-measurement method.

Conclusion
iPosi's deterministic RF loss-measurements substantially enhance spectrum utilization and optimize the use of the spectrum as anticipated in the 2012 PCAST report. The methodology presented here also extends to the protection of other environments -- homogeneous and mixed RF propagation environments -- as well as ensure compatible sharing with FSS, PAL to PAL, GAA to PAL, and GAA to GAA.

Appendix

Example of iPosi/TR-15-517 model

TR-15-517 parameters

Urban setting
Radar 10 Km off shore

AP -urban
    80% indoor   50% hant=3m 50% hant=6 to 18m EIRP 26 dBm
    20% outdoor hant=3m
    50 users/AP

AP antenna gain

$$a(h_{AP}) = 3.2(\log(11.75h_{AP}))^2 - 4.7 \ dB$$

Building loss
    20% 20dB
    60% 15 dB
    20 % 10 dB

TR 15-517 methodology

Randomly place users in the environment and apply antenna gain and building loss factors randomly according to the AP locations. Apply other random factors also to represent extended Hata (EHata). Conduct 100k Monte Carlo trials and determine results.

iPosi parameters

Naval radar antenna height 50 m from Fast Track report Table D-1. ITM and Simulation Parameters
Urban homogeneous environment
Path loss model EHata

iPosi methodology

Identify the main random variables and generate the standard deviation for them. (Not all are identified here).

1) Antenna gain

Antenna height. This is the same as floor height with the standard deviation determined by the 3 floor height values in TR -15-517

Antenna gain. The random floor height distribution was plugged into the antenna gain equation to determine the gain per antenna height.

$$a(h_{AP}) = 3.2(\log(11.75h_{AP}))^2 - 4.7 \ dB$$

Calculate standard deviation from

$$a(h_{AP}) = 8[.5\ a(3) + .5a(urv(6\ to\ 18)] + .2(3)\ \mathrm{dB}$$

This provides a standard deviation of 3.575 dB

2) Building loss
A standard deviation was generated from the distribution of antenna gain and was calculated as 6.633 dB from the building loss distribution.

3) Area uncertainty

The area standard deviation was taken directly from TR 15-517 table A-1 and is 8.1 dB.

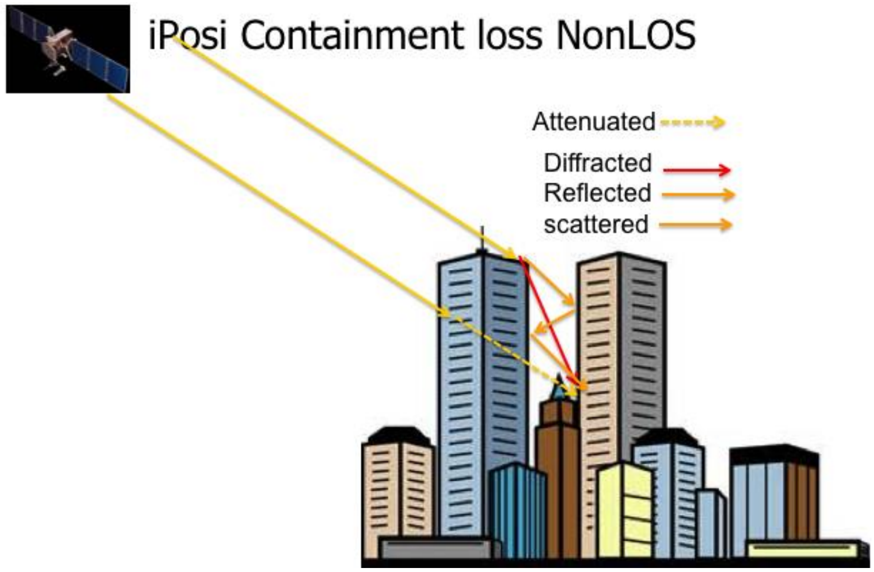
These 3 standard deviations were used to generate a single random variable of loss that provides a standard deviation of

$$\sigma_{loss} = \sqrt{\sigma^2{}_{ant\_ht} + \sigma^2{}_{bld\_loss} + \sigma^2{}_{loc}}$$

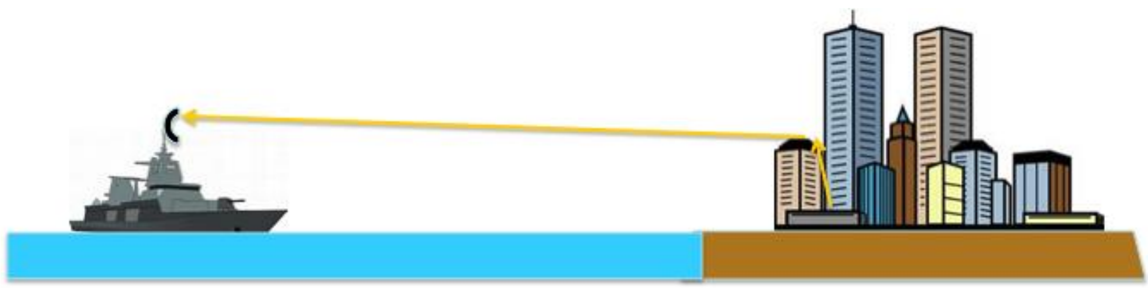
$$\sigma_{loss} = \sqrt{3.575^2{}_{ant\_ht} + 6.633^2{}_{bld\_loss} + 8.1^2{}_{loc}} = 11.1\ dB$$

The 95% tile can be estimated by multiplying by 1.645 to get 18.26 dB. This represents the 95% tile of loss from the 100k Monte Carlo trials.

iPosi provides a direct measurement of the loss from the AP indoor or outdoor to the estimated LOS ray. This can be the LOS from the top of a building as seen below. The lowest loss in the direction of the radar is used to set the loss value over the elevation angles of the GNSS satellite.



Next, this is related to the radar as seen below.



Additional factors such as GNSS signal frequency to 3.5 GHz loss correction can be applied using data such as the NIST report NISTIR 6055. Although the 3.5 GHz loss is on average higher than the GNSS frequency, we assume the loss to be the same in this analysis.

The iPosi measurement accuracy has 1dB standard deviation, which is 1.645 dB at 95% tile and is compared to 18.85 dB of the Monte Carlo stochastic method. This means either the capacity of the 3.5 GHz CBSD's can be increased 16.6 dB or the protection distance is reduced 16.6 dB using the path loss slope for the system. At 20dB/dec, a protection distance of 10 Km goes to 1.5 Km, and at 40 dB/dec, it goes to 3.85 Km.

This is only a single analysis done by iPosi, we anticipate the method will be refined within Winnforum for other scenarios and other factors will likely be considered.